CLAIMS

1. A method for enhancing image quality of a planar nuclear emission image acquired by a gamma camera, comprising the steps of:

(a) calculating weight values taking into account the physical configuration of the gamma camera;

(b) obtaining a two dimensional image of a spatial distribution of the pharmaceutical substance within the portion of the body by mathematically analyzing acquired data in conjunction with the weight values.

2. A method for obtaining a planar image of a portion of a body and enhancing image quality of at least one specific organ or volume of interest located within the portion of the body, administered with radio-pharmaceutical substance radiating gamma rays, by using single photon emission imaging, for determination of functional information thereon, comprising the steps of:

(a) acquiring at least one projection data of said portion of the body, by means of a gamma camera detector;

(b) determining the effective distance between the detector and the specific organ of interest;

(c) calculating weight values taking into account acceptance angles of the gamma camera detector and the effective distance;

(d) obtaining a two dimensional image of a spatial distribution of the pharmaceutical substance within the portion of the body by mathematically analyzing said data in conjunction with weight values.

3. The method of Claim 2 wherein the step of calculating weights values is taking into account the probability of a photon to be attenuated within the body.

4. The method of Claim 2 wherein a collimator with septa is used adjacent the detector, and the step of calculating weights values is taking into account the probability of a photon to penetrate the septa of the collimator.

5. The method of Claim 2 wherein the steps of acquiring the data projection comprises acquiring data relating to two opposing projections.

6. The method of Claim 2, wherein mathematically analyzing said data is done using iterative algorithm.

7 The method of Claim 6, wherein said iterative algorithm is applied at least in one of the iterations to a subset of the acquired data

8. The method of Claim 6, wherein said iterative algorithm is applied to data collected in list mode.

9. The method of Claim 2, wherein the determination of effective distance is done relaying on *a priory* knowledge of human anatomy.

10. The method of Claim 2, wherein the determination of effective distance is done relaying on patient measurements.

11. The method of Claim 2, wherein the determination of effective distance is done relaying on single photon emission image taken from another detector position.

12. The method of Claim 2, wherein the determination of effective distance is done relaying on other medical imaging modality.

13. The method of Claim 12, wherein the other medical imaging modality is selected from the group of X-Ray, CT, MRI, PET and Ultrasound imaging.

14 The method of claim 2 wherein two projections data of said portion of the body are acquired from positions that are substantially opposite to each other.

15. Method of 14 said two projections data are acquired using two dissimilar collimators.

16. The method of Claim 14, wherein the effective distance for processing data from both projections is half the distance between detector faces in said positions.

17 The method of Claim 14, wherein the effective distance associated with each is different.

18. The method of Claim 2, wherein the effective distance varies across the portion of the body

19. The method of Claim 18, wherein the effective distance varies across the portion of the body in such a way that voxels residing at said effective distance form a plane inclined to the surface of a detector.

20. The method of Claim 18, wherein the effective distance varies across the portion of the body in such a way that the voxels residing at said effective distance form a contiguous curved surface.

21. The method of Claim 18, wherein the effective distance varies across the portion of the body in such a way that the vixels residing at said effective distance form a non-contiguous surface.

22. The method of Claim 2, wherein the detector is adapted to detect emitted photons having incident angles in the range of 0 to more than 5 degrees.

23. The method of Claim 2, wherein the detector is adapted to detect emitted photons having incident angles in the range of 0 to about 90 degrees.

24. The method of Claim 2 wherein distances between different discrete elements of the portion of the body and corresponding discrete elements of the projection of the portion of the body on the detector substantially determined by the average distance between the detector and the organ to be imaged in the patient.

25. The method of Claim 2 wherein said reconstructing an image by processing said data comprises the steps of:

(a) dividing an area of the detector facing the body into M bins;

(b) dividing the portion of the body into N voxels;

(c) providing a set of values D_i (wherein $i = 1,\ldots,M$) reflective of the number of photons acquired by each bin;

(d) constructing a matrix P having matrix elements $P_{i,j}$ of weight values of the voxels of the portion of the body (wherein $i = 1,\ldots,M$ and $j = 1,\ldots,N$), the matrix P setting a relation between each bin of the detector and each voxel of the portion of the body;

(e) modeling a relation between said set of values D_i and a set of voxel values V_j of said image and deriving said set of voxel values V_j of said image, whereby said spatial distribution of the pharmaceutical substance indicating the functional information on said portion of the body is obtained.

26. The method of claim 25 wherein said bins are all equal in size.

27. The method of claim 25 wherein said bins not of equal in size.

28. The method of claim 25 wherein said voxels are all equal in size.

29. The method of claim 25 wherein said voxels are not of equal in size.

30. The method of claim 25 wherein dimensions of said bins are unequal to the dimensions of pixels in the obtained image.

31. The method of Claim 25 wherein the step of modeling a relation between said set of values D_i and a set of voxel values V_j of said image and deriving said set of voxel values V_j of said image comprises the step of solving a set of equations $D_i = \sum_{j=1}^{V} P_{i,j} V_j$ with respect to each value V_j.,(wherein i = *1,...,M)*.

32. The method of Claim 25 wherein the step of modeling a relation between said set of values D_i and a set of voxel values V_j of said image and deriving said set of voxel values V_j of said image comprises the step of solving a set of equations $D_i = \sum_{j=1}^{V} P_{i,j} V_j + E_i$ with respect to each value V_j, wherein E_i is a set of measurement errors.

33. The method of Claim 25 wherein the step of modeling a relation between said set of values D_i and a set of voxel values V_j of said image and deriving said set of voxel values V_j of said image comprises the step of solving an optimization problem for estimating a mean value $\lambda(V_j)$ of random variables V_j, using the D_i values measured by the detector.

34. The method of Claim 33 wherein said random variables V_j *are* Gaussian random variables.

35. The method of Claim 33 wherein said random variables V_j *are* Poisson random variables.

36. The method of Claim 33, wherein estimating the mean value $\lambda(V_j)$ of the random variables V_j, is carried out by calculating a maximum of the likelihood function

$$L[\lambda(D_i)] = \prod_{i=1}^{M} \frac{e^{-\lambda(D_i)}\lambda(D_i)^{D_i}}{D_i!},$$

with respect to the unknowns V_j.

37. The method of Claim 25 wherein the step of modeling a relation between said set of values D_i and a set of voxel values V_j of said image and deriving said set of voxel values V_j of said image comprises the step of solving a Bayesian optimization problem utilizing a likelihood and penalty functions.

38. The method of Claim 37, wherein the Bayesian optimization problem has the general form $V = \arg\max\{\ L[\lambda(D_i)] + \alpha F(V_j, V_k)\ \}$, where α is the weight that is given to the penalty function F.

39. The method of Claim 25 wherein the matrix P is a matrix in which each of the matrix elements $P_{i,j}$ is a function of an average distance and solid angle at which a detector bin having an index i is viewed from the voxel having an index j.

40. The method of Claim 25 wherein the matrix P is a matrix in which each of the matrix elements $P_{i,j}$ is a function of an average solid angle at which a detector bin having an index i is viewed from the voxel having an index j.

41. The method of Claim 25 wherein the matrix P is a matrix in which each of the matrix elements $P_{i,j}$ is a function of an average distance and solid angle at which a voxel having an index j is viewed from a detector bin having an index i.

42 . The method of Claim 25 wherein the matrix P is a matrix in which each of the matrix elements $P_{i,j}$ is function of an average solid angle at which a voxel having an index j is viewed from a detector bin having an index i.

43. The method of Claim 25 wherein the matrix P is a matrix in which each of the matrix elements $P_{i,j}$ is a function of a solid angle and distance at which a detector bin having an index i is viewed from a center of a voxel having an index j.

44. The method of Claim 25 wherein the matrix P is a matrix in which each of the matrix elements $P_{i,j}$ is a function of a solid angle at which a detector bin having an index i is viewed from a center of a voxel having an index j.

45. The method of Claim 25 wherein the matrix P is a matrix in which each of the matrix elements is a function of a solid angle and distance at which a center of a voxel having an index j is viewed from a detector bin having an index i.

46. The method of Claim 25 wherein the matrix P is a matrix in which each of the matrix elements $P_{i,j}$ is a function of a solid angle at which a center of a voxel having an index j is viewed from a detector bin having an index i.

47. The method of Claim 25 wherein the modeling of the relation between said set of values D_i and a set of voxel values V_j of said image, is biased by an attenuation effect of the patient body.

48. The method of Claim 47 wherein the matrix P is a matrix in which each of the matrix elements $P_{i,j}$ is influenced by the attenuation density that exists

on the path of the photons that emanate at voxel *j* and arrive at bin *i*, for each detector position *k*.

49. The method of Claim 47 wherein the matrix *P* is a matrix in which ea ch of the matrix elements $P_{i,j}$ is influenced by the attenuation density that exists on the path of the photons that emanate at voxel *j* and arrive at bin *i*, for each detector position *k* and for each energy peak of the radio-pharmaceutical substance that is used.

50 . The method of Claim 25, further comprising the step of providing a collimator between said portion of body and said detector, and wherein the matrix *P* is a matrix in which each of the matrix elements $P_{i,j}$ is multiplied by the area of bin *i* that can be seen from voxel *j* through the collimator

51. The method of Claim 2 wherein said detector is adapted to move relative to the body

52 The method of claim 2 wherein the step of calculating weight values involves taking into account probability of photon to undergo Compton scattering by within the body of the patient.

53. The method of claim 2 wherein the step of calculating weight values involves taking into account probability of photon to penetrate trough a septa of the collimator.

54. The method of claim 2 wherein the step of calculating weight values involves taking into account energy of the emitted photon.

55. The method of claim 2 wherein the step of calculating weight values involves taking into account measured energy of the detected photon.

56. The method of claim 2 wherein the step of calculating weight values involves taking into account both energy of the emitted photon. and the measured energy of the detected photon.

57. The method of claim 2 wherein the step of calculating weight values involves taking into account camera imperfections associated with specific bin.

58. The method of Claim 2 wherein said at least one crystal is a semiconductor crystal.

59. The method of Claim 2 wherein said detector includes at least a pair of septa mounted along an axis of the detector, the septa provided for limiting the field of view.

60. The method of claim 2 wherein plurality of planar images are obtained each with different set of weights.

61. The method of claim 60 wherein said plurality of different sets of weights are calculated taking into account plurality of effective distances;

62. The method of claim 60 wherein said plurality of different set of weights are calculated taking into account plurality of emitted photon energies.

63. The method of claim 60 wherein said plurality of different set of weights are calculated taking into account plurality of detected photon energy ranges.

64. The method of claim 60 wherein said plurality of obtained planar images are displayed side by side

65. The method of claim 60 wherein plurality of planar images are displayed one after the other

66. The method of claim 60 wherein at least two obtained images are combined to form combined image.

67. The method of claim 66 wherein at least two obtained images are combined to form combined image by averaging the at least two obtained images.

68. The method of claim 66 wherein at least two obtained images are combined to form combined image by weighted average.

69. The Method of claim 68 wherein coefficients of said weighted average are stored in an averaging coefficients map.

70. The method of claim 69 wherein coefficients of averaging coefficients map are determined by statistical analysis of the quality of obtained images.

71. The method of Claim 2 wherein distances between different discrete elements of the portion of the body and corresponding discrete elements of the projection of the portion of the body on the detector substantially determined by the average distance between the detector and the organ to be imaged in the patient.

72. An apparatus for obtaining a planar image of a portion of a body and enhancing image quality of at least one specific organ or volume unit of interest located within the portion of the body, administered with radio-pharmaceutical substance radiating gamma rays, by using single photon emission imaging, for determination of functional information thereon, comprising:

(a) a detector adapted to detect photons emitted from said portion of the body, said detector having at least one photon detector crystal, the detector adapted to convert photons into electric signals;

(b) a position logic circuitry for processing said electric signals and thereby deriving there from data indicative of positions on said photon detector crystal, where the photons have impinged the detector; and

(c) a data analysis processor for obtaining an image of a spatial distribution of the radiopharmaceutical substance within said portion of the body by processing said data and in conjunction with weight values derived taking into account the physical configuration of the gamma camera;

(d) obtaining a two dimensional image of a spatial distribution of the pharmaceutical substance within the portion of the body by mathematically analyzing said data in conjunction with weight values.

73. The apparatus of claim 72, wherein an image enhancing processor is further provided communicating with the data analysis processor.

74. The apparatus of Claim 72, wherein the detector is adapted to detect photons having incident angles in the range of 0 to more than 5 degrees.

75. The apparatus of Claim 72, wherein the detector is adapted to detect photons having incident angles in the range of 0 to more than 10 degrees to reach the detector.

76. The apparatus of Claim 72, wherein the detector is adapted to detect photons having incident angles in the range of 0 to about 90 degrees.

77. The apparatus of Claim 72 wherein said at least one crystal is a semiconductor crystal.

78. The apparatus of Claim 76 wherein said semiconductor crystal is a crystal selected from the group consisting of Cadmium-Telluride (CdTe), Cadmium-Zinc-Telluride (CeZnTe) and Lead Iodine (PbI).

79. The apparatus of Claim 72 wherein said detector includes at least a pair of septa mounted along an axis of the detector, the septa provided for limiting the field of view.

80. The apparatus of Claim 72, wherein the detector is provided with a collimator having holes that are symmetric, such as circular, square or hexagonal shaped holes.

81. The apparatus of Claim 72, wherein the detector is provided with a collimator having direction bias holes favoring detection from a predetermined frontal direction and limiting detection from other directions.

82. The apparatus of Claim 72, wherein the detector is provided with a collimator having non-symmetric holes.

83. The apparatus of Claim 72, wherein the detector is provided with a collimator having holes of different dimensions along different axes, such as ellipse or rectangular shape holes.

84. The apparatus of Claim 72, wherein the detector is provided with a collimator having bores of cylindrical, conic or other converging or diverging shapes.

85. The apparatus of Claim 72, wherein the detector is provided with a collimator having bores of different shape or size or both.

86. A method for enhancing image quality of a planar nuclear emission image acquired by a gamma camera, substantially as described in the present specification, accompanying drawings and appended claims.

87. An apparatus for enhancing image quality of a planar nuclear emission image acquired by a gamma camera, substantially as described in the present specification, accompanying drawings and appended claims.